Discovery of Short-timescale Oscillations in the Transition Region by CLASP

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Abstract

High cadence spectroscopic observations by CLASP reveal that intensity fluctuations of blue and red peaks of the hydrogen Lyman-alpha line (121.57 nm) recurrently appear in the quiet Sun at short timescale. The intensity fluctuations of the blue and red peaks are opposite in phase to each other: the blue peak is enhanced during the decease of the red peak, and vice versa. Similar intensity fluctuations also can be seen in Mg II h & k profiles observed with IRIS. It is suggested that the short-timescale oscillatory or torsional phenomena take place in the transition region or the upper chromosphere.

CLASP Observation

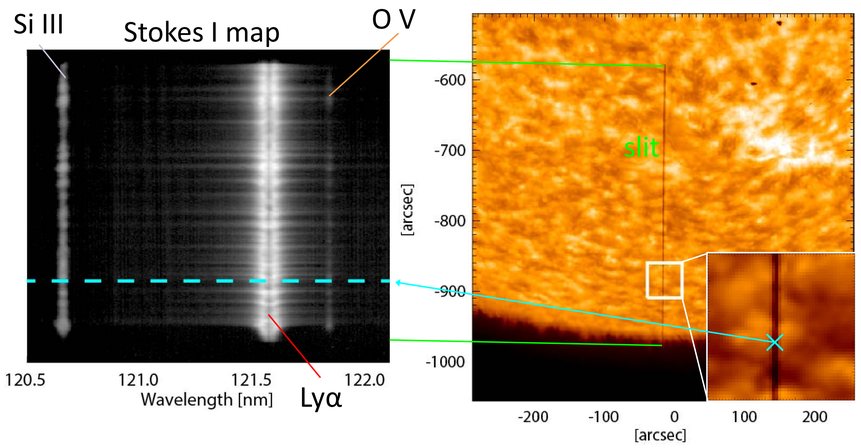


Fig.1 Stokes I map with CLASP (left) and CLASP/SJ Lyα image (right)

Summary of CLASP observations			
Date	2015/09/03	Wavelength	Lyα (121.57nm)
λ- sampling	4.8pm/pixel	Pixel scale (space)	1.1”
Duration	280s	Cadence	0.3s
Slit length	400”	Waveplate rot.	4.8s/rotation

- The running average over 4.8s is calculated from a time series of Stokes I maps to remove effects by the waveplate rotation.
- High pass filtered Stokes I map is made by subtracting the slow-varying components (~30s running temporal average) from the original time profile.

Evolution of Lyα Profile

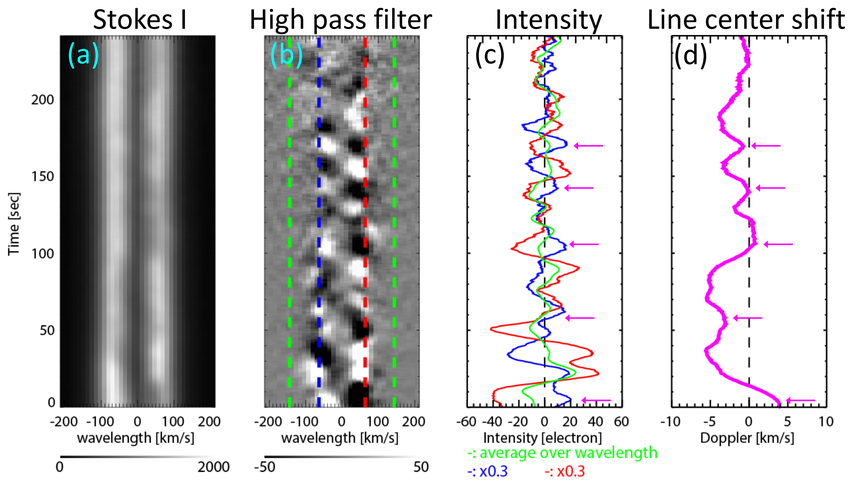
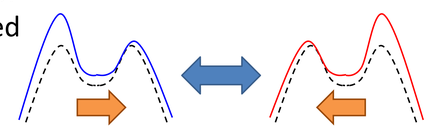


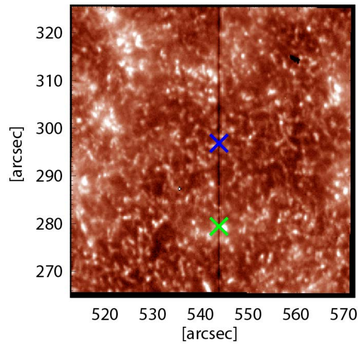
Fig.2 Temporal evolution of Stokes I profiles at “X” of Fig.1 for (a) Lya & (b) high-pass-filtered Lya. Time profile of (c) the high pass filtered intensity and (d) Doppler velocity.

- The intensity of the blue and red peaks fluctuates at time scale shorter than 30s in opposite phase with each other. Such fluctuation is visible in raw Stokes I data.
- The short timescale fluctuations also can be seen in the Doppler shift of a central dip of the Lyα line. Their range is +/- 10 km/s. When the central dip of the Lyman-alpha line moves redward, the blue peak tends to be enhanced, and vice versa.
- Such alternate intensity changes of the blue and red peaks are more clearly observed in the bright areas but in the period without the fast propagating intensity disturbances discovered by CLASP/SJ (Kubo et al. 2016).

The alternate intensity changes of the blue and red peaks are caused by the short-timescale shifts of the central dip of the line that originates in the chromosphere-corona transition region.



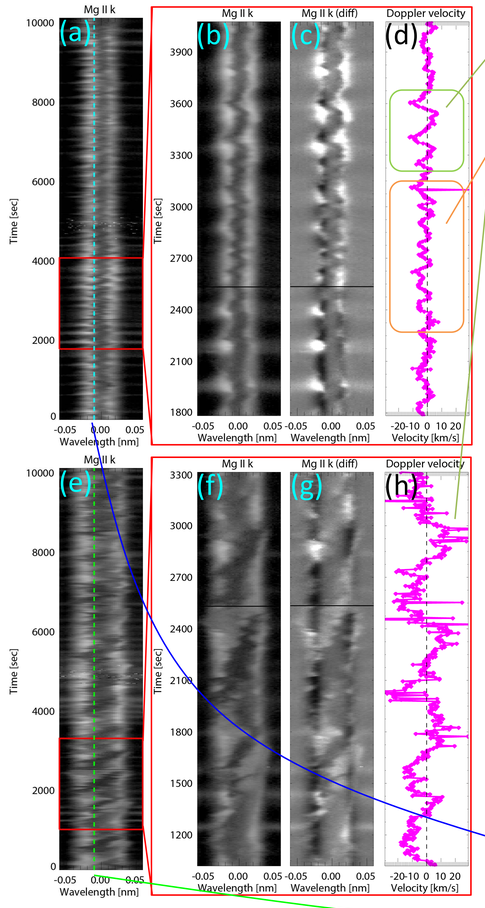
IRIS Observation



Summary of IRIS observations	
Date	2013/09/22
Mode	Sit-and state
Cadence	5.1s
Duration	3.5 hour
Target	quiet Sun
Coordinate	(537”, 295”)

Fig.3 IRIS SJI (1400)

Evolution of Mg II h & k Profile



Shock wave (~5min)

Short-timescale fluctuations (~30s)

Fig.4 Temporal evolution of Mg II k profiles at “X” with blue color of Fig.2 for (a) the entire period & (b) the period in the red box. (c) Mg II h profile after subtraction of the average (d) Doppler velocity of the line center. Panels (e) – (h) are same as the upper panels but for the profiles at “X” with green color.

- Similar short-timescale intensity fluctuations caused Doppler shifts of the line center are also observed in Mg II h & k profiles.
- The range of the Doppler shift is similar to that observed by CLASP.
- Such short timescale fluctuation is more clearly observed in the region without the shock waves.

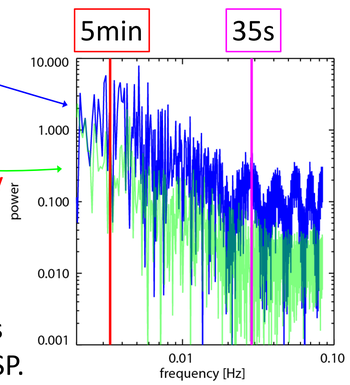


Fig.5. Power spectrum of intensity along the dashed lines in Fig.4